Assignment 8

1) Consider a function given by
\[ f(x) = \begin{cases} 0 & \text{for } x < -1 \\ x + 1 & \text{for } -1 \leq x \leq 0 \\ 1 - x & \text{for } 0 < x \leq 1 \\ 0 & \text{for } x > 1 \end{cases} \]
The Fourier series of \( f(x) \) from -1 to 1 contains
- only nonzero sine terms
- only nonzero cosine terms
- both nonzero sine and nonzero cosine terms
- Only the \( A_0 \) term

Accepted Answers:
only nonzero cosine terms

2) Consider a function given by
\[ f(x) = \begin{cases} 0 & \text{for } x < -1 \\ -x - 1 & \text{for } -1 < x < 0 \\ 1 - x & \text{for } 0 < x < 1 \\ 0 & \text{for } x > 1 \end{cases} \]
The Fourier coefficient \( A_0 \) is equal to
- 1
- 2
- -2
- 0

Accepted Answers:
0

3) Consider the function \( f(x) = 4 \sin(3x) + 2 \cos(2x) \) defined from -1/2 to 1/2. The Fourier coefficient \( A \) is equal to
4) The wave function of a quantum mechanical particle is given by \( A \cos(2x) \). The momentum of this particle can be either equal to \(-2\hbar\) or equal to \(2\hbar\).  
- is exactly equal to \(2\hbar\)
- is exactly equal to \(-2\hbar\)
- can be either equal to \(-2\hbar\) or equal to \(2\hbar\)
- None of the above

5) For a quantum mechanical particle in a box between \(x = 1\) and \(x = 3\), the wavefunction of the ground state is proportional to
- \(\cos(2\pi x)\)
- \(\cos(\pi x)\)
- \(\sin(\pi x)\)
- None of the above

6) Consider the differential equation \(y'' - 2xy' + 2ny = 0\). This equation can be put into Sturm-Liouville form using \(q(x) = 0\) and \(p(x) = r(x)\) equal to
- \(1\)
- \(x^2\)
- \(e^{-x^2}\)
- None of the above

7) Consider the integral involving the Hermite polynomials \(H_v(x)\) given by
\[
\int_{-\infty}^{\infty} H_v(x)H_{v'}(x)e^{-x^2} \, dx
\]
The above integral is equal to zero unless \(|v - v'|\) equals
- 0
- 1
8) The associated Legendre Polynomials $P^m_l(x)$ satisfy the ODE

$$\left(1 - x^2\right)\frac{d^2 P^m_l(x)}{dx^2} - 2x\frac{dP^m_l(x)}{dx} + \left(l(l+1) - \frac{m^2}{1-x^2}\right)P^m_l(x) = 0$$

When this equation is put into the Sturm-Liouville form, the value of $r(x)$ is equal to

- $-\frac{m^2}{1-x^2}$
- $l(l+1)$
- $1$
- None of the above

Accepted Answers: 0

9) The Legendre Polynomials $P_l(x)$ satisfy the orthogonality relation

$$\int_0^1 P_1(x)P_2(x)dx = 0$$

$$\int_{-1}^1 P_1(x)P_2(x)dx = 0$$

$$\int_{-1}^1 P_1(x)P_2(x)\cos xdx = 0$$

$\int_{-1}^1 P_1(x)P_2(x)d\theta = 0$

None of the above

Accepted Answers: 1

10) Consider the equation

$$xy'' + (1-x)y' + ny = 0$$

This equation can be converted into Sturm-Liouville equation by multiplying the entire equation by $r(x)$ such that $r(x)$ is equal to

- 1
- $x$
- $e^{-x}$
- None of the above
Accepted Answers:

$e^{-x}$